ROYAL COMMISSION ON THE NORTHERN ENVIRONMENT

J.E.J. FAHLGREN, COMMISSIONER

AN ALTERNATIVE ENERGY OPTION
FOR
NORTHERN ONTARIO

by

Energy Probe

1980

AN ALTERNATIVE ENERGY OPTION

FOR

NORTHERN ONTARIO

Christopher Conway
Robert Crow
Michael Schell
Norman Rubin

March 17, 1980

ENERGY PROBE
43 Queen's Park Crescent East
Toronto, Ontario
978-7014

TABLE OF CONTENTS

1. Introduction.. 1

2. Alternative Energy Technology Review 5

3. Energy Supply and Demand Forecast to 2001 27

4. Alternative Energy Policy Implementation 43

5. Conclusions 51

6. Footnotes 52

7. Bibliography 55

BACKGROUND

This report was made possible through a research grant from The Royal Commission on The Northern Environment. The views expressed herein are those of the authors, and not necessarily those of The Commission.

1. INTRODUCTION

The rapid and largely unpredictable changes that have characterized the Canadian energy scene recently have spurred many new insights into the nature of our energy problems. Three of these in particular will have a significant effect on the focus of energy decision making in the future.

The first is that conservation and renewable energy can and must assume a role of greater importance in future energy supply and demand planning. While conservation and renewables are not yet seen as the backbone of energy policy, they are at least considered to be an essential complement to our traditional sources of energy supply. And as energy prices continue to climb and the environmental impacts of traditional energy sources become of ever greater concern, the role of conservation and renewable energy can only increase.

The second insight is that energy strategies can serve not only as the products of, but also as inputs to, our social, economic and environmental objectives. In other words, we are now beginning to appreciate that energy supplies do far more than simply make energy available: they also create employment, influence the degree of local autonomy, and change the natural landscape. Thus, rather than simply letting energy policy flow from demographic and economic

trends, we have the opportunity to use energy policy as, for example, a regional economic development tool (while, of course, benefitting from the energy it provides anyway).

The third insight is the growing acceptance that the impacts of energy policies are often felt, and the solutions to our energy problems are often to be found, at the local or regional level. And although many energy policy discussions are still dominated by federal oil pricing debates, local and regional planning authorities are becoming aware of, and are beginning to exercise, some of their options in the energy planning field. Many of the barriers to effective local and regional energy planning can be expected to diminish in importance, as the need for local input into energy policy increases.

While the effects of these energy attitudes are relevant to the entire nation, nowhere will they be felt more than in Canada's Northern regions. The North is seen by some as a "frontier" and by others as a "homeland", preceptions which are in many cases simply incompatible. As a result, the North now stands at a crossroads with respect to its economic, physical and cultural development. As we hope to demonstrate in this paper, this development is intricately tied to the energy strategy chosen for the North. While a comprehensive analysis of Northern development options is beyone the scope of this paper, we intend to demonstrate that an understanding of the role of energy policy and the energy options with which we are faced, is critical to any decision regarding Northern development.

The nature of the link between energy policy and socio-economic development is particularly important in Northern Ontario. For many years, the North has been in an economically disparate position relative to the rest of the province; it has been subject to fluctuating and often uncontrolled social and economic pressures; it has unique and rather delicate environmental features; and it serves as a home to a small population living mostly in scattered small communities. Any development policy proposed for the North must reflect these social and economic realities, and must attempt to avoid past mistakes while taking advantage of existing options. The purpose of this paper is to outline how one particular facit of this development - the energy component - could be handled. In developing such a proposal for action, we have tried to take account of both the specific characteristics of Northern Ontario and the insights that have developed from recent energy experiences.

We hope to show in this paper

(a) that conservation and renewable energy technologies can provide an important contribution to the Northern Ontario energy system, by introducing the technologies associated with an alternative energy policy and examining the issues associated with their development and utilization in Northern Ontario;

(b) that the development of an efficient and renewable energy system in the North is compatible with a wide

range of socioeconomic development patterns and objectives, by examining a supply and demand option for 2001 which relies, wherever possible, on renewable energy and conservation technologies;

(c) that an alternative energy future can be implemented, at least in part, through the use of local and regional policy and planning mechanisms that can be tailored to suit the conditions of Northern Ontario, by outlining a package of programs and institutional reforms through which renewable energy and conservation can be put into place.

2. ALTERNATIVE ENERGY TECHNOLOGY REVIEW

1. The Soft Energy Path

Optimism and support for the rapid development of conservation and renewable energy technologies is the product of the "soft energy" perspective. The term, coined by Amory Lovins,[1.] refers to an energy policy which is efficient, relies on renewable energy, is diverse and flexible, and which matches energy sources to the scale and quality of the end use tasks to be performed.

Over a 50 to 75 year time frame, a soft energy path seeks to transform a relatively inefficient energy system relying almost exclusively on non-renewable sources of energy, to an efficient and renewable energy economy. A number of soft energy futures prepared for the United Kingdom, Canada and the United States suggest a stabilization of overall energy consumption and the phasing out of nuclear power and other thermal generation, and fossil fuels. Thus, while a soft energy future implies an entirely different set of energy technologies, it also suggests a different institutional framework within which energy planning should be conducted. In this section, we will examine the technical aspects of the soft energy path, especially as they relate to Northern Ontario.

2. Matching End Uses and Sources of Supply

Energy is consumed at the point of end use for three basic

purposes: heat, motion, and a few "high quality" tasks such as lighting, communications, etc. A key issue in determining the efficiency with which an energy system operates is the extent to which the quality of the end use is matched to the quality of energy a particular source provides. Renewable energy technologies can provide - at the appropriate scale and quality - energy to accommodate each of the end uses.

Figure 2.1

Matching End Uses with Renewable Sources

Source	Low Temp. Heat	High Temp. Heat	Motion	Other
active solar heating	X			
passive solar construction	X			
tracking or concentrating solar collector	X	X		
wood (direct combustion)	X	X		
wind generation		X		X
small scale hydroelectricity		X		X
photovoltaic conversion		X		X
methanol, ethanol and hydrogen		X	X	
conservation	X	X	X	X

3. Passive Solar Space Heating

While Northern Ontario may at first seem an unlikely location for passive solar space heating applications, it actually has two distinct advantages over more temperate regions:

(a) it has a lower than average frequency of cloud cover;[2.]

(b) its long heating season, high average heating loads and high fuel costs all contribute to relatively economical passive solar heating use.

To be sure, the first of these advantages is partly offset by low sun angles and short daylight periods in late fall and early winter, while inflated costs for building materials and other "soft path" hardware slightly decrease the economic attractiveness of passive solar. However, these special features of the Northern Ontario environment suggest the so called "micro-load passive" approach to solar heating, as popularized by the Saskatchewan Conservation House in Regina.

Several house designs have already been completed utilizing this "micro-load" approach. The designs have three main features:

(a) the minimization of conduction heat loss with high levels of insulation, multiple glazing on windows, insulating shutters for night-time use, the elimination of north face glazing, the use of earth berms, etc.;

(b) the elimination of haphazard infiltration heat loss through careful sealing, vapour barriers, design changes that minimize wall penetrations for wiring and plumbing, the use of vestibules as entrance airlocks, etc.;

(c) the routing of ventilation air through an air-to-air heat exchanger which transfers the heat contained in

outgoing stale air to incoming fresh air at high heat capture efficiencies.[3.]

Thus, such designs concentrate both on reducing the total heating load of the house (thus increasing the relative role of occupant waste heat), and on taking advantage of passive solar gain (via the use of large south facing windows and a large quantity of "thermal mass" such as concrete, stored water, etc.).

One particular design by Allen, Drerup and White [4.] for a 1200 square foot house in Keewatin NWT, features an additional 200 square foot enclosure facing south, which serves as both a work space and an entrance airlock that has a buffering effect on the cold inflow of air eventually entering the structure. With these features, the designers claim a total annual space heating load of only 10 GJ for the entire house, located practically on the Arctic Circle. Perhaps most importantly, the structure utilizes no exotic technologies. The most sophisticated piece of equipment - the heat exchanger - could be constructed locally of plywood and plastic sheet.

While such design results indicate the enormous potential of passive solar applications in Northern Ontario, we have decided to be somewhat more conservative in our expectations for new housing stock. Because the economics of Northern passive are not well documented, we have used an estimate for new housing starts of 50 GJ annual heating load per detached structure and 40 GJ per attached

unit. While such an estimate probably understates the true potential of passive solar potential in Northern Ontario, we feel it could be used as a reasonable estimate in the near-term. Further research on design modifications appropriate to Northern use and the economics of passive solar should be undertaken immediately, with a view toward utilizing locally available resources.

4. Small Scale Hydroelectricity

The traditional source of electrical power for isolated communities located beyond the reach of the provincial electric grid has been diesel generation. Diesel electric generation has been increasingly called into question due to its extremely high fuelling costs, the limited amount of power it can provide, and its adverse environmental impacts. Fortunately, however, many Northern communities now dependent on diesel generation are located close to sites that have significant hydro-electric potential to provide the community with power. At some sites, natural drops and waterflows allow the direct harnessing of hydro power without the need for and the expense of dams or channels to concentrate the flow.

A number of Northern native groups have stated their opposition to hydroelectric development on Northern rivers, siting previous examples of development where treaty lands were flooded, wild rice areas destroyed, fish migration altered or stopped, and trapping areas flooded by river diversions or dams. Clearly, the issues associated with the James Bay project in Quebec and other developments in Ontario provide a rationale to doubt the net social

and environmental benefits of hydro development in such areas. However, an inventory of indigenous energy resource potential would not be complete without some mention of hydroelectricity. We wish to repeat, though, that our analysis does not necessarily indicate support for the use of hydro: such an analysis should be determined by the groups in Northern Ontario who would be affected. In addition, where hydro development is impossible or deemed inappropriate, wind generation potential provides an alternative (in fact in those areas where hydro potential appears to be low, wind potential appears to be high).

At present there are nine hydroelectric generating stations located north of or in the vicinity of the 50th parallel. All stations are of medium to high capacity. In total, there exists at present 30 units with a total capacity of 990 MW and an average output of 632 MW. All of this power is fed onto the provincial grid from which a portion of the North's power is obtained. Towns located north of 50° that are connected to the grid are Moosonee, Red Lake, Ear Falls, Sioux Lookout, Pickle Lake, Nakina and Crow River. (Crow River is the location of the only diesel electric facility connected to the grid). At present, while there are a number of studies underway, no major hydro projects are slated for Northern Ontario.

From a technical perspective, hydroelectricity offers several advantages of diesel electric generation: it is renewable, indigenous, probably more economical, and non-polluting. Implemented at the local level (i.e. non-grid connected), transmission lines (with costs

of as high as $34,000/km) become less crucial, and transmission losses are minimized. A recent innovation of significance to remote Northern communities is a prefabricated hydroelectric generating unit called the mini-Hydel station. This unit can be air transported to remote locations, and assembled locally. Each installation would be capable of producing 100 - 500 kW of power. While the costs of the mini-Hydel unit are relatively high, the long term operating costs are estimated by Ontario Hydro to be lower than diesel.

Ontario Hydro has recently completed a preliminary evaluation of 19 Indian communities and the potential for small scale hydro generation within a 24 km radius of each community. A formula was developed to determine the peak electrical load for each community:

per Native household: 2 kW
per nursing station: 5 kW
per government residence: 3 kW
per store: 5 kW
per airport: 2 kW
per telephone system: 5 kW
plus an allowance for government facilities such as weather stations

Annual energy requirements were estimated using a 40% load factor assumption. The following table provides a summary of the results of the Hydro document. Information is given only for the site which appears to have the best potential; some communities actually have a number of potential sites within the 24 km radius.

Figure 2.2 [5.]

Hydroelectric Inventory for 19 Remote Native Communities

Community	Population	Est. Peak Demand	Present Diesel Capacity	# Sites	Type	Estimated Capacity	% of Peak Demand	Comments
Sandy Lake	1105	500 kW	525 kW	2	Dam	700 kW	140	dam now exists
Deer Lake	326	150	25	3	Falls	157	105	mini-Hydel (?)
Poplar Hill	171	70	--	1	Falls	400	571	
Pikangikum	766	290	375	3	Rapid	--	--	
North Spirit Lake	183	80	30	3	Rapid	75	94	dam and flooding required
Sachigo	201	100	30	4	--	--	--	no data
Bearskin	273	150	50	5	Falls	350	233	dam required
Muskrat Dam	123	75	15	5	Falls	1100	1467	no dam required
Round Lake	434	250	300	5	Dam	--	--	dam and flooding required
Cat Lake	237	140	60	2	Rapid	--	--	no data
Big Trout Lake	632	330	375	3	Rapid	--	--	dam and flooding required
Angling Lake	166	70	18	3	Rapid	--	--	as above
Kingfisher	219	100	30	2	--	--	--	no data
Wunnummin	260	130	25	4	Rapid	620	477	small dam
Kasabonika	377	160	40	5	Rapid	--	--	no data
Webequie	404	180	125	3	--	--	--	
Landsdowne House	202	160	300	5	--	--	--	no data

Figure 2.2 (continued)

Community	Population	Est. Peak Demand	Present Diesel Capacity	# Sites	Type	Estimated Capacity	% of Peak Demand	Comments
Fort Hope	649	240 kW	375 kW	3	Rapid	460 kW	192	series of dams needed
Summer Beaver	211	110	--	3	Rapid	200	182	dam needed

The Ontario Hydro report that 10 of the 19 communities appeared suitable for hydro development, but that only 6 had "good" potential, in other words, development appeared to be economically feasible and alteration or damming of streamflow was felt to be unnecessary. These six were Winnummin, Sandy Lake, Deer Lake, Poplar Hill, Pikangikum and Muskrat Dam.

5. Wind Electric Generation

In cases where hydroelectric development is deemed inappropriate, over expensive or is impossible, wind electric generation provides an excellent alternative source of power. The community of Sandy Lake (53°N) is expected to pay over $2.00 per gallon of diesel fuel this year; this figure has been estimated to increase to as much as $6.00 per gallon by 1992. For economic reasons, then, wind generation may provide an excellent opportunity to relieve the region's dependence on imported energy sources.

A wind system can be erected and maintained (and in some cases, possibly produced) by local labour. Although wind electric systems are fairly capital intensive, they have low operating costs, and thus insulate the user from fuel increases.

Communities north of 50° have expressed a great deal of interest in wind generated power, for social and economic and environmental reasons. It is presently the policy of the federal government to provide the initial capital costs for the development of local wind systems for Native communities, who in turn must pay

replacement and maintenance costs.

Because the wind blows with varying intensity, the power output of a wind generator is subject to large fluctuations. The power output of a wind generator is proportional to the cube of the windspeed (up to its maximum output). At wind speeds of less than 15 kph, the output of the system may only be sufficient for pumping water; at speeds above 16 kph, electrical generation becomes increasingly feasible. Figure 2.3 following indicates isovents (i.e. lines of equal average windspeed) for the Northern Ontario region.

Figure 2.3

Isovents in Northern Ontario (mph)

All isovents in the preceding figure are adjusted to the 30m elevation. The map indicates that the areas of greatest wind potential are along the shore of Lake Superior and along Hudson's Bay. It should be noted, however, that wind data for the area north of 50° is based only on the reports of 8 weather monitoring stations, and hence may not reflect the existence of local wind regimes.

Because of wind speed fluctuations, either electrical storage or some backup generating source must be considered. A 1975 study suggested that the latter - that is, a hybrid wind and diesel system - made economic sense:

> "...wind diesel hybrid systems offer potential for reducing the cost of power supply to remote telecommunications stations if the winds are good (12.5 mph) and fuel costs are above $1.00 a gallon. A number of sites in Northern Ontario fit these criteria which indicates that the development of wind/diesel hybrid systems for such applications should be undertaken..." [6.]

In related research, the Ontario Research Foundation found similar evidence to support the immediate use of larger wind power generators (greater than 100 kW capacity) for community power supply in seven of 27 Treaty 9 communities. Figure 2.4 indicates those communities which meet the criteria of good wind speed and high fuel costs. Two of the communities, located on the shore of Hydson's Bay, have mean annual wind speeds of 13 mph or

greater and diesel fuel costs of more than \$2.00 per gallon.

Figure 2.4

Communities with High Wind Power Potential [7.]

Settlement	1974 Population	Estimated # homes	Location	Estimated mean annual wind speed at 100'	Fuel Cost per gallon (1976 dollars)	Potential
Big Trout Lake	629	105	53° 49' N	12.5	\$1.10	good
Webequie	325	54	52° 59' N 90° 55' W	12.0	\$1.50	good
Bearskin	283	45	53° 55' N 90° 55' W	12.5	\$1.39	good
Kasabonika	244	41	53° 40' N 88° 04' W	12.5	\$1.39	good
Fort Severn	211	35	56° N 87° W	13.5	\$2.58	very good
Angling Lake	113	20	53° 50' N 85° 57' W	12.5	\$1.10	good
Winisk	175	30	55° 30' N 85° 30' W	12.9	\$2.13	very good

6. Wood and Wood-Derived Liquid Fuels

Natural methanol or wood alcohol was originally produced by the destructive distillation of forest products. Most methanol in North America is now produced from flared natural gas or other light hydrocarbons and is employed in the synthesis of formaldehyde, or used as antifreeze or solvents in manufacturing processes.

But within the last few years, as current sources of liquid fuels become more scarce and costly, interest in the production of methanol from renewable feedstocks has increased. The production of methanol from forest products involves three steps: gasification of the harvested wood, modification of the gas produced, and liquifaction of the gas. Gasification occurs when heat is applied to the wood feedstock in the absence of oxygen, producing a gas containing hydrogen, carbon monoxide, carbon dioxide and hydrocarbons. In an intermediate step, the gas produced from the gasifier is "shifted" to obtain the proper chemical balance of carbon monoxide, hydrogen and carbon dioxide. At the same time the gas can be compressed and impurities removed from the gas stream.

To increase the energy content of the gas, it has been suggested that additional hydrogen or methane (natural gas) be introduced into the gas stream. These introductions would improve both the energy efficiency and the economics of the final product; but in a Northern context, where indigenous resource content is of some concern, entirely renewable feedstocks might be more advisable.

The final stage of the manufacturing process involves the conversion of the modified gas to methanol at pressures from 50 to 150 atmospheres and temperatures from 230°C to 270°C. The end product is a clear liquid with an energy content approximately half that of gasoline. While no liquifaction plants now exist in Canada, several gasification facilities are in operation. A wood gasifier is supplying fuel for a gas turbine for the generation of

electricity in conjunction with conventional fossil fuels at a thermal generating facility in Selkirk, Manitoba. In Ontario, Inco has been experimenting with wood gasification, and CIL of Canada has just developed a fluidized bed combustion unit which is now operating near Kingston.

As a liquid fuel, methanol can substitute for petroleum products in almost all areas. It can be used as a source of energy for home heating or as a fuel for the generation of electricity. However, the preferred use for methanol would appear to be as a substitute for gasoline in the transportation sector.

There has been some debate concerning the availability of forest products for energy uses, and some authors in the field of resource management have expressed concern about future conflicts between the current forest industry and a large methanol industry. However, it would appear that sufficient resources exist for both industries, and that benefits can accrue to each.

There are a number of supply options for a methanol industry. Significant potential exists for "tree farming", in which high yields of forest products are achieved over a short time period (3 to 5 year crop rotations). Such an option, however, appear limited to parts of Southern Ontario; it is doubtful whether Northern Ontario soil and climatic conditions could support such an intensive growth cycle.

Two viable options for Northern Ontario, however, are mill wastes and forest residue (that part of the tree which is left after conventional forest harvesting has taken place). The residue fuels available at mill sites are comprised primarily of bark, sawdust and shavings. In many cases the producers of these wastes incur a penalty, since the wastes must be disposed of. The conventional disposal techniques involve combustion in teepee ovens or removal for disposal as landfill. While these wastes may be used for the production of methanol, in some cases they may be better applied to producing steam or burned directly to provide energy for the pulp and paper sector itself. A development strategy based on promoting increased self sufficiency within the forest products industry is far more efficient, as conversion losses can be minimized. In British Columbia, more than one-third of the energy consumed by the pulp and paper industry is generated from mill wastes (sawdust, wood chips, bark).

The second, and most promising supply option for Northern methanol production is wood residue. In Ontario, 50% of the allowable hardwood cut and 85% of the allowable softwood cut is actually all that is removed during logging, due to the prevailing utilization standards of the industry. In addition to this waste, there is the "nonmarketable" slash and unutilized trees (diseased, small and undesirable species) that could be used for methanol production.

Estimates as to the accumulations of these residues in Ontario forests range from 5.4×10^6 ODT (oven dried tons)[8]. to

8.5×10^6 ODT annually[9]. For Northern Ontario (figures are not available for the area entirely north of 50°) the figure which we will employ is closer to 7×10^6 ODT annually[10]. This figure is at best a ball park estimate due to the lack of complete information. The accumulation of these wastes can be divided further into regions.

Figure 2.5

Bark and Wood Fibre Production from Primary Milling and Forest Harvesting Operations (Crown Lands)

Region	Bush Residue (x1000 ODT)	Bush Unutilized Wood Fibre (x1000 ODT)
Northwestern	701	387
North-Central	1567	550
Northern	1176	850
Northeastern	923	849
Total	4367	2636
	7003	

(7003 ODT = 6353 OD tonnes)

Assuming that a 1000 tonne per day methanol facility requires 759 thousand oven-dried tons annually, on a theoretical basis, 6.5 million oven-dried tonnes could sustain eight plants with annual output of 736 gallons of methanol. If this fuel were to be used to displace gasoline in the Ontario transport sector, it could account for almost 14% of the energy consumed.[11] Such a figure represents an upper bound: more detailed environmental, economic and social impact analysis would be required before a firm estimate

of actual output could be derived.

Optimally sized methanol production facilities would have an annual production capability of 100 x 10^6 gallons, and would require 800,000 ODT of wood feedstock per year. According to current research, the minimum size for an economically viable facility would be 50 million gallons per year of output.

A number of benefits could be obtained from a Northern Ontario methanol industry: a firm employment base, a less vulnerable transport sector, export revenues, and possibly new opportunities for the forest industry to engage in effective reforestation practices. Environmentally, the gasification of biomass feedstocks will produce very low sulphur emissions and no significant increase in long term atmospheric CO_2 loadings.

Although sufficient methanol could be produced from Northern facilities to totally displace current gasoline consumption, it probably makes more sense in the short term to consider methanol an export commodity: low methanol-gasoline blends could easily be achieved with no significant changes to the vehicle stock. A move toward "neat" methanol burning vehicles would have to proceed in pace with a national effort, since it would not be possible to justify neat burning vehicle manufacture for an area as small as Northern Ontario.

The direct combustion of wood products for a number of applications already occurs in the North, where about 8% of domestic

heating and cooking is wood supplied.

7. Active Solar Heating

Considerations relevant to the design of an active solar system for space and water heating are

(a) the peak intensity of sunlight;

(b) daily and seasonal variations in sunlight intensity;

(c) the percentage of total heating requirements to be supplied by the system.

Because of its latitude, Northern Ontario receives sunlight at a lower peak intensity than does southern Ontario, and receives less sunlight year round, much of which is concentrated in the summer months. While this situation does not pose insurmountable problems, it does require some changes to the design of the solar system. These changes involve modifying the ratio of collector area to storage volume; modifying the collector area itself; and changing the expectation of the percentage of heat to be supplied by the system.

Generally, solar systems installed in Northern Ontario would require greater storage volume per unit of collector area to take maximum advantage of incident sunlight when it does occur. In the winter months, considerable auxiliary heating would be required to allow for reduced sunlight intensity. Unfortunately, very little research has been performed on solar systems suitable for Northern

use; as a result we have remained conservative in our estimates of active solar system penetration into the building stock.

8. Peat

Canada has the second largest peat deposits in the world, next to the Soviet Union, covering an estimated 520,000 square kilometres and containing the energy equivalent of 500 trillion cubic feet of natural gas. Such estimates must be tempered, however, by the potentially serious environmental problems associated with peat harvesting. A 120 MW thermal electric generating station, for example, would require one million metric tons of peat per year covering 57 square kilometres. Serious land reclamation problems may exist after a peat bog has been harvested, and peat is a non-renewable resource.

Bog locations in Northern Ontario cover the eastern part of the region, surrounding the west shore of Hudson's Bay. Because of the environmental uncertainties associated with its extraction and the near total lack of data detailing its potential, we have not included any estimates for peat use in our supply scenario. Further investigation should, however, proceed.

9. The Regional Impacts of Alternative Energy Sources

Two issues associated with indigenous energy resource utilization in Northern Ontario require further research attention: employment impacts and effects on regional balance of trade. We shall present here only a summary of these issues.

Generally, speaking, renewable energy development is more labour intensive than conventional energy extraction; it can provide a more permanent and stable employment base; and it tends to generate a wider range of employment opportunities.

A recent federal government energy and employment program proposed the creation of about one million man-years of employment in the energy sector through capital expenditures in electricity, oil and gas projects totalling about \$50 billion.[13.] Energy Probe developed an employment scenario which focussed on renewable energy and conservation technologies, the results of which indicated that alternative energy strategies generate considerably more employment than conventional energy policies. (See Figure 2.6 following).[14.]

In terms of regional balance of trade, the Northern Ontario region's energy purchases for external supplies represent an enormous outflow of dollars from the region (and, by extension, employment). Most serious among these is the purchase of diesel fuel. Any attempts to either reduce dependence on imported energy or to produce energy from local sources would represent a net gain

to the regional economy.

Figure 2.6

Conventional and Alternative Energy Employment Generation

Energy Source	Capital Cost per Man Year of Employment
Active Solar Heating	$30,882
Wind Generation	$17,027
Methanol Production	$16,667
Residential Conservation	$23,730
Information Programs	$11,356
Oil and Gas Development	$53,600
Electricity Generation	$37,500

These statistics reinforce the point that alternative energy technologies can act as an input to regional development goals rather than just an output of other development trends.

The extent to which such economic and social benefits can be achieved are discussed in the following section, which outlines possible energy supply and demand situations over the next 20 years in Northern Ontario.

3. ENERGY SUPPLY AND DEMAND FORECAST TO 2001

1. The Study Area

The Commission's terms of reference being the area north of 50° latitude, we have chosen a study area roughly analogous to this part of the province. Because much of the data required to develop a supply and demand forecast is recorded on a county or district basis, we have chosen the districts of Cochrane and Kenora as being roughly representative of the area north of 50°.

Figure 3.1

The Study Area

2. Underlying Forecasting Assumptions

Opposition to (or skepticism about) a soft energy future often stems from the belief that it can only develop within the context of "reduced expectations", that is, less affluent and more restrictive lifestyles, reduced rates of (or negative) economic growth; and that it can only be implemented through a much greater degree of government involvement in peoples' lives. In addition, some believe that while alternative energy sources are important, they will not be sufficient in and of themselves to provide the energy we will require in the future.

In order to dispel this notion, we have developed an energy supply and demand strategy while relying almost exclusively on published government estimates of future economic and demographic trends. Also, we have limited our choice of energy technologies to those which are either presently available, or which could imminently be commercially available. Our use of existing and forecasted social and economic indicators does not signal our support for the type of society and economy they suggest. Rather, we intend to demonstrate that economic growth need not be hindered in any way by the use of renewable energy (in fact, as the previous section has indicated, the reverse may well be true). Thus, we have allowed for economic growth and higher "activity levels" in the Northern economy only in order to demonstrate that such growth can proceed - if chosen - despite the use of renewable energy.

3. Forecasting Method

The following supply and demand forecasts were developed as follows:

(a) present energy supply and demand levels were estimated on a fuel supply and end use basis;

(b) social and economic indicators were projected;

(c) the energy impacts of these social and economic trends were estimated, and then adjusted downward to account for the effects of conservation;

(d) fuel market shares were developed for each end use for the year 2001, using a "renewables first" approach.

The terminal forecast year of 2001 was chosen to indicate the short and medium term effects of a soft energy path for Northern Ontario. A longer time frame would suggest the potential for even greater efficiency and higher levels of renewable energy penetration.

The goal of energy supply and demand policy is ostensibly to "optimize" social, economic and environmental considerations. For example, although reasonable energy prices are a goal of most energy strategies, in some cases slightly higher energy costs might be accepted in return for greater local labour intensity. Similarly, some inefficiency might be tolerated if it satisfied certain local autonomy objectives. This point is particularly important in a small region such as Northern Ontario, where different optimization patterns might exist compared to, for example, the province as a

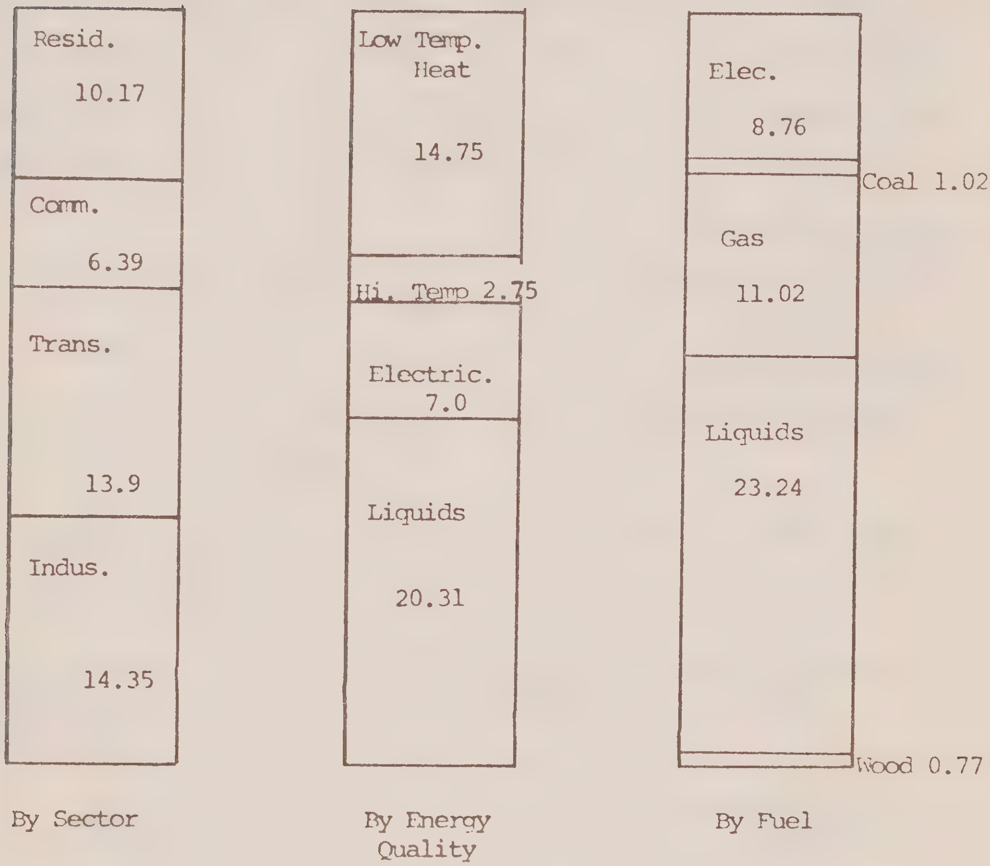
whole. One example illustrates this situation. Northern Ontario imports the majority of its energy supplies, but does utilize indigenous wood for a number of applications. A "carte blanche" efficiency program, while reducing regional dependence on imported fuels, might also have the effect of reducing the demand for indigenous wood, thus having negative employment effects. This problem makes necessary a net employment impact analysis, the recommendations of which might be to tolerate inefficiency in some cases in order to preserve employment in the forestry sector.

We do not suggest that our energy supply and demand forecasts are optimal in this sense. We have developed the forecasts in the spirit of approximation (made necessary, in large part, by the near total lack of firm socioeconomic and energy data in the region), and with the intent of identifying key institutional and technological issues that are relevant to alternative energy and conservation implementation in general. Thus, we do not intend to suggest that a particular source should provide "X"% of end use energy needs; we do imply that given a particular penetration objective, certain institutional reforms may be necessary.

The following tables outline the forecast results by sector, end use and source of supply.

Figure 3.2 [1]

Present Energy Supply and Demand Summary



(all data in 10^{15} J)

Figure 3.3

Residential Energy Demand Forecast

Item	Base Year Value[1.]	Transition	Forecast Value
Population[2.]	154,805		143,535
Persons/Dwelling[3.]	3.8		3.4
Housing Stock[4.]	31,776 (s) 8,962 (o) 40,738 (tot)		42,216 (tot)
Attrition 1976-2001[5.]		5%	
Units Lost 1976-2001		2,037	
Existing Stock Remaining in 2001			38,701
New Starts 1976-2001[6.]		2,636 (s) 879 (o) 3,515 (tot)	
Housing Stock in 2001			(s) (o) pre76 30,187 8,514 post76 2,636 879 total 32,823 9,393
Space Heating Demand per Unit[7.]	211 GJ (s) 148 GJ (o)		100 GJ (pre76 -s) 70 GJ (pre76 -o) 50 GJ (post76-s) 40 GJ (post76-o)
Sector Space Heating Demand	8×10^{15} J		3.79×10^{15} J
Water Heating Saturation[8.]	87%		100%
Water Heating Demand[9.] per Unit	40 GJ		24 GJ
Sector Water Heating Demand	1.4×10^{15} J		1×10^{15} J
Appliance Energy Demand per Unit[10.]	19 GJ		19 GJ

Figure 3.3 (continued)

Item	Base Year Value	Transition	Forecast Value
Sector Appliance Energy Demand	$.77 \times 10^{15}$ J		$.80 \times 10^{15}$ J
Residential Energy Demand Summary			
Low Temperature Heat	9.4×10^{15} J		4.79×10^{15} J
Electrical	$.77 \times 10^{15}$ J		$.80 \times 10^{15}$ J
Total	10.17×10^{15} J		5.59×10^{15} J

Figure 3.4

Commercial Energy Demand Forecast

Item	Base Year Value	Forecast Value
Population	154,805	143,535
Employment Rate [1.]	35%	38%
Commercial Labour Force as % of Total Empl. [2.]	49%	55%
Commercial Labour Force	26,613	29,994
Space Conditioning [3.] Energy Demand per Employee	201 GJ	141 GJ (pre76 stock) 100 GH (post76 stock)
Sector Space Conditioning Energy Demand	5.35×10^{15} J	4.09×10^{15} J
Electricity Demand [4.] per Employee	39 GJ	25 GJ
Sector Electricity Demand	1.04×10^{15} J	$.75 \times 10^{15}$ J
Commercial Energy Demand Summary		
Low Temperature Heat	5.35×10^{15} J	4.09×10^{15} J
Electricity	1.04×10^{15} J	$.75 \times 10^{15}$ J
Total	6.39×10^{15} J	4.84×10^{15} J

Figure 3.5

Transportation Energy Demand Forecast

Item	Base Year Value	Forecast Value
Present Provincial Energy Demand/Capita	69×10^{9} J	
Northern Ontario Energy Demand/Capita [1.]	89.5×10^{9} J	
Sector Energy Demand	13.9×10^{15} J	
(a) air[2.] (10%)	1.39×10^{15} J	
(b) rail[3.] (6%)	0.83×10^{15} J	
(c) road passenger[4.] (42%)	5.84×10^{15} J	
(d) road truck [5.] (42%)	5.84×10^{15} J	
Population Ratio	1.0	0.93
Air Travel [6.]		
(a) load factor ratio	1.0	1.0
(b) mobility/capita ratio	1.0	1.2
(c) fuel demand ratio	1.0	0.9
(d) energy demand	1.39×10^{15} J	1.40×10^{15} J
Rail Travel [7.]		
(a) load factor ratio	1.0	1.0
(b) total movement ratio	1.0	1.25
(c) fuel demand ratio	1.0	0.9
(d) energy demand	0.83×10^{15} J	0.94×10^{15} J
Road Passenger Travel [8.]		
(a) load factor ratio	1.0	1.1
(b) mobility/capita ratio	1.0	1.2
(c) fuel demand ratio	1.0	0.6
(d) energy demand	5.84×10^{15} J	3.56×10^{15} J
Road Truck Travel [9.]		
(a) load factor ratio	1.0	1.0
(b) total movement ratio	1.0	1.25
(c) fuel demand ratio	1.0	0.8
(d) energy demand	5.84×10^{15} J	5.84×10^{15} J

Figure 3.5 (continued)

Item	Base Year Value	Forecast Value
Transportation Energy Demand Summary		
Liquid Fuels	13.9×10^{15} J	11.74×10^{15} J
Total	13.9×10^{15} J	11.74×10^{15} J

Figure 3.6

Industrial Energy Demand Forecast

(a) Industrial Employment Analysis

Industry Group	% of Industrial Employment[1]	# Employees[2]
Mining	22	6,079
Agriculture, Fishing, Forestry, Trapping	13	3,592
Manufacturing		
(a) Wood	17.5	4,835
(b) Paper	17.5	4,836
Construction	12	3,316
Transportation, Communications and Utilities	18	4,974
Total	100	27,632

(b) Energy Use by Industry Group[3]

Industry Group	Energy Use/Employee	% Energy Derived From			
		Elec.	Oil	Coal	Nat. Gas
Mining	$.6 \times 10^{12}$ J	81	19	--	--
AFF & T	.1	20	80	--	--
Manufacturing					
(a) Wood	.58	23	41	--	36
(b) Paper	1.4	19	22	11	48
Construction	.1	20	80	--	--
TC & U	.1	20	80	--	--

(c) Total Industrial Energy Consumption

Industry Group	(10^{15} J)
Mining	3.76
AFF & T	
Construction	1.19
TC & U	
Mf'g (Wood)	2.8
(Paper)	6.6
Total	14.35

Fuel Source	(10^{15} J)
Electricity	5.19
Coal	.73
Natural Gas	4.18
Liquids	4.25
Total	14.35

Figure 3.6 (continued)

(d) 2001 Industrial Energy Demand: Scenario One

- employment declines to 24,544 (45% of total employment)
- increased output/employee offset by increased efficiency
- 2001 energy demand

$$14.35 \times 10^{15}\ \text{J} \times \frac{24,544}{27,632} = 12.75 \times 10^{15}\ \text{J}$$

- distribution by fuel:

4.61×10^{15}	J	electricity
.64		coal
3.71		natural gas
3.78		oil

(e) 2001 Industrial Energy Demand: Scenario Two

- employment increases 30% to 35,922
- efficiency per employee increases 10%
- 2001 energy demand

$$14.35 \times 10^{15}\ \text{J} \times \frac{35,922}{27,632} \times .9 = 16.79 \times 10^{15}\ \text{J}$$

- distribution by fuel:

6.07×10^{15}	J	electricity
.85		coal
4.89		natural gas
4.97		oil

(f) 2001 Industrial Energy Demand: Scenario Three

- mining and manufacturing employment increases 50%
- other sector employment remains constant
- zero efficiency improvements
- 2001 energy demand

$$21.02 \times 10^{15}\ \text{J}$$

- distribution by fuel:

7.57×10^{15}	J	electricity
1.12		coal
6.39		natural gas
5.95		oil

Figure 3.7

Active Solar Applications for 2001

1. Residential

(a) Housing Stock Summary (2001)

	singles	other	total
pre76	43,549	12,283	55,832
post76	3,434	1,145	4,579
total	46,983	13,428	60,411

(b) Active Solar Space Heating

(i) Goal for 2001: 6,000 installations (10% capture)
(ii) Heating Contribution of Each System: 40%
(iii) Installation Schedule

1980 - 1989- 150/yr = 1,500
1990 - 1995- 250/yr = 1,500
1996 - 2001- 500/yr = 3,000
6,000

(evenly distributed over four cells in matrix above)

(iv) Energy Impacts: $.217 \times 10^{15}$ J

(c) Solar Water Heating

(i) Goal for 2001: 4,000 installations (6.6% capture)
(ii) Heating Contribution of Each System: 50%
(iii) Installation Schedule

1980 - 1989- 100/yr = 1000
1990 - 1995- 150/yr = 900
1996 - 2001- 350/yr = 2100
4000

(iv) Energy Impacts: $.05 \times 10^{15}$ J

2. Commercial

(a) Goal for 2001: capture 10% of heating load with solar

(b) Energy Impacts: $.41 \times 10^{15}$ J

3. Industrial

Insufficient data to establish penetration objectives

4. Total Active Solar Contribution: $.68 \times 10^{15}$ J

5. Solar as Percentage of Low Temperature Heat in 2001: 7.66%

Figure 3.8

Renewable Electricity Applications for 2001

1. General

(a) Current Electrical Requirements: 8.76×10^{15} J

(b) Forecasted Electrical Requirements: $6.16 - 9.12 \times 10^{15}$ J

(c) Forecasted Requirement for Dependable Generating Capacity Given 40% Load Factor
low - 485,000 kW
high - 722,000 kW

2. Wind Generation

(a) Assume 25% capacity factor wind generators

(b) Community Scale Systems: 200 of 200kW units

(c) Individual Scale Systems: 500 of 20kW units

(d) Total Wind Generated Electricity: $.395 \times 10^{15}$ J

3. Small Scale Hydroelectricity

(a) Total of 19 Identified Sites: 4062 kW

(b) Assume 25% are environmentally, socially and economically attractive: 1015 kW

(c) Assume 75% capacity factor

(d) Total Hydro Generated Electricity: $.024 \times 10^{15}$ J

4. Total Renewable Electricity: $.419 \times 10^{15}$ J

5. Renewable Electricity as Percentage of Total Electricity Required:

4.6 - 6.8%

Fiqure 3.9

Methanol Applications for 2001

1. Transport Sector Demand, 2001: 11.74×10^{15} J

2. Penetration of Methanol by Sub-Market

(a)	air	0%	
(b)	rail	5%	$.047 \times 10^{15}$ J
(c)	road Pass.	15%	$.534 \times 10^{15}$ J
(d)	road truck	10%	$.584 \times 10^{15}$ J

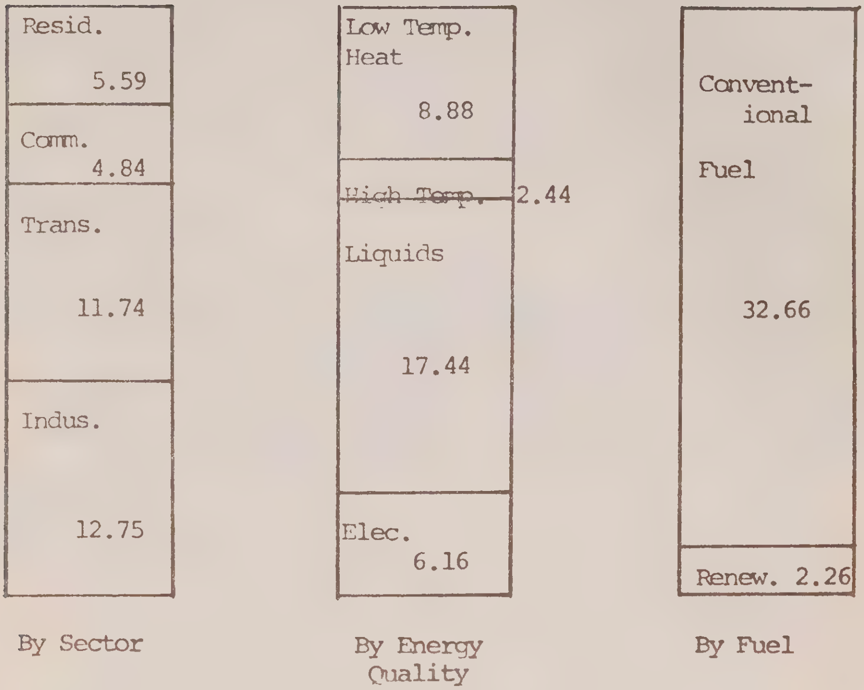
3. Methanol Yield per 100 mgpy Facility: 7.9×10^{15} J

4. Total Methanol Penetration 1.165×10^{15} J

5. Methanol as Percentage Of Transport Energy Demand: 9.92%

Figure 3.10

Forecasted Energy Supply and Demand Summary *



(all data in 10^{15} J)

* Only the Industrial Scenario One is shown

4. ALTERNATIVE ENERGY POLICY IMPLEMENTATION

1. Background

The previous sections have outlined the "technical" possibilities for an alternative energy future in Northern Ontario. It is essential, however, to complement such a technical strategy with programs through which the supply and demand objectives can be achieved.

A number of previous studies[1.] have indicated the types of programs suitable for large scale (provincial or national) implementation. These studies have demonstrated that three basic mechanisms exist through which energy reforms can be implemented:

(a) education and information: some programs provide information on the social, economic and environmental benefits of alternative energy and conservation, thus establishing a moral or attitudinal context within which energy decisions can be made;

(b) market: through grants, subsidies, tax credits, energy pricing reform, depreciation allowances, etc., programs can establish a favourable economic climate for the development of renewable energy and conservation;

(c) direct regulation: in cases where (a) and (b) are seen to be inadequate, direct regulation can be employed to prohibit specific detrimental energy supply and demand

practices, thus establishing an appropriate legal framework for alternative energy practices.

To a moderate degree, each of these programs have already been implemented in Canada. Ontario Hydro television advertisements encourage consumers to adopt conserving habits by informing them of certain conservation opportunities; gasoline excise taxes and the automobile air conditioner tax provide an economic disincentive to waste gasoline; and building codes and the automobile fleet performance standard establish legal limits on energy consumption.

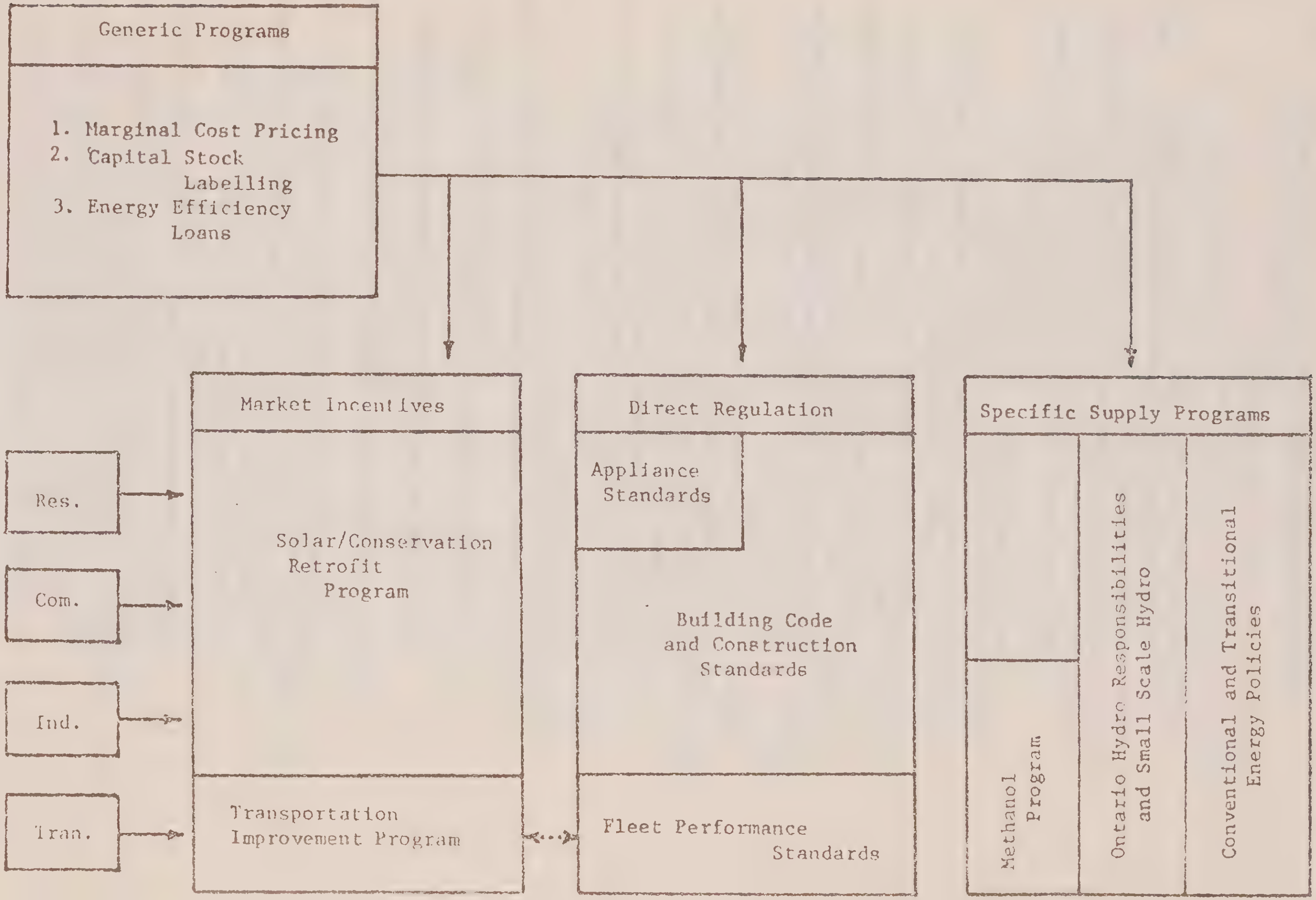
In a report to the Royal Commission on Electric Power Planning, Energy Probe examined the application of such a set of programs in the Ontario context. If implemented successfully, the programs could result in an energy growth rate of only 0.6% per year, and could culminate in the provision of one-fourth of our energy from renewable sources by the year 1993. (See Figure 4.1 following).

2. The Northern Ontario Situation

While such programs are by no means irrelevant to the implementation of a soft energy path in Northern Ontario, we must adopt a somewhat different approach in order to accommodate the situation north of 50°. Our initial intent is to develop programs, wherever possible, which can be administered locally, relying only where necessary on provincial or federal mechanisms.

Figure 4.1

Provincial Alternative Energy Implementation Strategies



Several characteristics of Northern Ontario suggest the need for such a tailor made approach:

(a) because of its economically disparate position, local implementation that results in employment for local residents would contribute to greater economic (and energy) self reliance in the region;

(b) to the extent that government involvement would be required, their actions should perhaps be one step removed from traditional government agencies because of possible public distrust over past government actions in the region;

(c) other pressing concerns facing Northern residents may have prevented the full development of the types of conservation attitudes that have developed in Southern and urban areas;

(d) the type of information suitable for the North will be different from that in the South because of cultural, social and economic differences between the regions;

(e) the probable public response to standard (i.e. Southern) economic incentives may not be as intense as those that would occur in the South (in part, this situation could be improved by additional information,but we must also examine the structure of the incentives themselves);

(f) any conservation program requires a capital outlay, which because of income and institutional reasons, may be impossible for a large number of Northern residents;

(g) direct regulation must be sensitive to Northern conditions,

and not simply superimposed after having been designed for a different region;

(h) the North consists essentially of two types of developments: towns and cities, and isolated communities. Because the former are more closely tied into provincial politics and economics, different approaches will be required in each case;

(i) perhaps most important, an energy strategy for the North is also a strategy for greater economic self reliance and equity, a strategy to increase individual and community health and welfare, and a strategy to protect the Northern environment from careless resource extraction. Since an intricate link exists between energy policy and community development opportunities, to simply superimpose standardized implementation procedures would be to neglect what is in many ways, the most important aspect of energy policy (that is, its "non-energy" aspects).

3. Implementation Procedures

Given the preceding situation, an alternative energy policy for Northern Ontario must proceed in two main phases. The role of the first is to develop an informational and attitudinal climate that is favourable to alternative energy; the second involves the actual design and implementation of procedures to achieve the goals and objectives outlined in Figures 3.3 - 3.9 above.

4. Establishing a Climate for Alternative Energy

Information, motivation and jurisdictional problems are likely to be detrimental to the development of alternative energy in the North. Several methods exist to overcome these problems, including but not limited to

(a) the institution of manpower and employment training programs to familiarize workers with construction and insulation techniques, wind and solar technologies, and to ensure the fulfillment of local employment objectives;

(b) the channelling of information through Native groups, local councils (where applicable) and the allocation of experienced personnel to community workshops and seminars, etc.;

(c) the conducting of a detailed energy resource inventory north of 50°, including a detailed energy supply and demand analysis, wind regimes, and other relevant climatic and environmental issues;

(d) the institution of local energy decision making and advisory boards, whose initial responsibility would be to determine the exact nature of the goals and criteria which Northern energy policy might fulfill;

(e) revision of energy regulations with the intent of vesting greater decision making authority in local hands (i.e. (d) above);

(f) the development of information and advisory agencies;

(g) the construction of wind, solar and conservation pilot projects to demonstrate issues associated with Northern applications and to familiarize potential workers and the community at large with the technologies;

(h) the enforcement of federal and provincial legislation, as deemed appropriate given (d) above, for example, fleet performance standards, energy pricing policies and possibly building code revisions;

(i) ensuring Native group representation in any issues where Native lands are likely to be affected;

(j) enactment of policies to ensure the use of local manpower in energy developments.

(k) the postponement of any conventional energy developments until such time as increased local input can be guaranteed, and until a fuller understanding of Northern energy options and objectives can be gained.

5. Program Implementation

Once a favourable climate has been created, actual implementation of conservation and renewable energy technologies can proceed. These programs are mostly of a market or incentive nature, and could include

(a) free structure energy auditing;

(b) the allocation of federal and provincial grant and loan assistance through local councils, Native groups, regional

government offices and industries to assist in the financing of conservation and alternative energy activities;

(c) the development of a government/private sector agency with citizen and government representation to conduct research on, and pilot testing of, methanol production facilities, and to assist in the development of Southern markets for methanol exports from the region;

(d) special financial incentives and workshops for builders to ensure that new housing and commercial structures are optimally efficient;

(e) property and income tax incentives for those who install alternative energy technologies.

6. Summary

Despite its uniqueness, the North has rarely been considered an entity in itself. For social, economic and cultural reasons, the North is unique, and any responsive energy policy must take account of Northern conditions. While the preceding discussion of implementation options can, at this point, only be general, there is certainly the potential to develop information flows and programs which are suitable to the Northern environment.

5. CONCLUSIONS

In this paper we have attempted to demonstrate that energy policy must proceed with a recognition of regional social and economic problems and potential. An alternative energy policy that focusses on renewable energy and conservation seems the only way to ensure that the North's interests are reflected in energy terms.

The rationale for an alternative Northern energy future can be seen in a broader context also. Many countries will soon require technologies suitable for Northern application, such as Scandanavia. Thus, while satisfying Northern Ontario development goals, the province and Canada as a whole could benefit.

As stated earlier, the North now stands at a crossroads. The energy policy eventually chosen for the North will have significant effects on the environmental and cultural character of the region. Energy problems are certainly a key element in the current character of Northern Ontario. A policy favouring renewable energy and conservation can be consistent with a number of development options, and should not be seen as limiting the choice of those options. A soft energy path is constrained less by technological and economic issues than by our willingness to consider the North as a unique region that should exercise control over its own future.

6. *FOOTNOTES*

Chapter Two

1. Lovins, Amory, "Energy Strategy: The Road Not Taken?", in Foreign Affairs, October 1976.
2. F.K. Hare and M.K. Thomas, Climate Canada, Figure 3.18, p.56. (1979)
3. R.W. Besant, R.S. Dumont, and G. Schoenau, "The Saskatchewan Conservation House: Some Preliminary Performance Results." University of Saskatchewan, Saskatoon, 1979.
4. Personal communication with Gregory Allen. The design is part of The Demonstration Houses Keewatin Project, sponsored by the Northwest Territories Housing Corporation.
5. Data from Ontario Hydro, An Inventory of Potential Hydroelectric Powersites for the Supply of Power to Remote Native Communities in Northern Ontario, March 1979.
6. Ontario Research Foundation, An Analysis of the Potential for Wind Energy Produced in Northwestern Ontario, 1975
7. ibid.
8. R. J. Hall, Resource Availability and Utilization of Forests for Energy, Ontario Ministry of Natural Resources, 1976.
9. Advisory Group on Synthetic Liquid Fuels, Liquid Fuels in Ontario's Future: Findings and Recommendations, Ontario Ministry of Energy, 1979.
10. This is an average of expected yields from Northern regions.
11. This does not take into account the fact that efficiency improvements are realized from the use of methanol in the range of 25%.
12. Dr. T. B. Reed, Proceedings, React '78: A Symposium on Economics of Renewable Energy and Energy Conservation Options, The Biomass Energy Institute, Winnipeg, 1978.
13. Gillespie, Alistair, presented at The Conference of First Ministers, February, 1978.
14. Chris Conway and David Brooks, Energy and Employment Alternatives, Energy Probe, Toronto, June 20, 1978.

Chapter Three

Figure 3.2

1. All data is derived from the analysis in following figures, except for energy quality distribution, which required an estimate of the energy quality required by the industrial sector. The assumption was made that of the non-electrical energy consumed by industry, 70% was required for liquid fuel uses and 30% was required for high temperature applications.

Figure 3.3

1. Most base year data refers to 1976, and much of the remainder to 1971. Adjustments were made to standardize all data to 1976 real or estimated values.

2. TEIGA, Ontario Population Projections by Regions and Counties, November 1978 (assumes low fertility; 30,000 net external migration; internal migration at 0.54% of Ontario population).
3. Statistics Canada, as quoted in Ontario Statistics 1978, Queen's Printer, Toronto. The 2001 estimate represents a decline in dwelling unit occupancy that matches the forecasted rate of decline for the province as a whole.
4. Statistics Canada, 1971 Census, Specified Housing Characteristics.
5. Assumed to equal provincial rate.
6. Assumed to be nearly equal to the current housing stock, since little incentive exists to construct at high density.
7. The provincial average for space heating demand is about 116 GJ (singles) and 81 GJ (other). Our higher Northern Ontario estimates are a reflection of larger family size, more severe climatic conditions, and less efficient housing stock. Our estimates are probably on the high side.
8. Statistics Canada, 1971 Census, Specified Housing Characteristics.
9. We have increased the provincial average of heating demand by 15% to accommodate higher dwelling unit occupancy, the predominance of single detached units, and the existence of (at least in the winter) colder ground water.
10. No data exists for appliance saturations, except for Ontario Hydro's Energy Application Survey (biennial) which relates to a much larger area. By assuming appliance use at 90% of the Ontario average, we have probably overestimated for many dwellings. We have assumed that higher future saturations will be offset by increasing appliance efficiency, yielding zero net growth per dwelling unit.

Figure 3.4

1. Slightly lower than the provincial rate, due to relatively high concentration of the population in the younger age cohorts.
2. TEIGA, Northeastern and Northwestern Statistical Profile, 1979. the 55% estimate for 2001 reflects a general move toward higher service sector employment.
3. The figure is higher than the provincial average of 141 GJ to accommodate severe climate and the general quality of the building stock.
4. ibid.

Figure 3.5

1. 30% higher than the provincial average to reflect greater distances between communities and the adverse effects of cold weather on engine performance.
2. Provincial figure is 8%; Northern Ontario air travel is expected to be higher due to lack of road access to many communities.
3. as per provincial figure.

4, 5. remaining energy demand split evenly between road passenger and road truck due to near total absence of marine mode traffic.

6,7,8,9. as per provincial expectations. See Energy Probe, Energy Planning in a Conserver Society: Implementation Strategies, January 1979.

Figure 3.6

1. 1971 data from Northeastern and Northwestern Statistical Profile.
2. Employment was matched to 1976 total employment level. The manufacturing disaggregation is based on an estimate in Brian Bee, Agglomeration Economies in Ontario Industries, Ryerson Polytechnical Institute, 1979.
3. Energy use per employee from Ontario Statistics 1978 (provincial data). Fuel disaggregations for industry groups are from Ontario Statistics 1978, except for mining, which is based on conversations with Dr. David Brooks of Energy Probe Ottawa.

Chapter Four

1. Energy Probe, Energy Planning in a Conserver Society: Implementation Strategies, January 1979; Vince Taylor, Energy: The Easy Path, Union of Concerned Scientists, Cambridge Mass., 1979.

7. BIBLIOGRAPHY

---

1. Chris Conway and David Brooks, Energy and Employment Alternatives, Energy Probe, 1978.
2. Energy Probe, Energy Planning in a Conserver Society: Implementation Strategies, January 1979.
3. Royal Commission on the Northern Environment, Issues Report, December 1978.
4. Ministry of Treasury, Economics and Intergovernmental Affairs, Northeastern Ontario Statistical Profile and Northwestern Ontario Statistical Profile, 1979.
5. Ministry of Industry and Tourism, Profiles of Ontario Municipalities, 1979.
6. Lovins, Amory, "Energy Strategy: The Road Not Taken?", in Foreign Affairs, October 1976.
7. Ministry of Treasury, Economics and Intergovernmental Affairs, Statistical Appendix to the Northeastern Ontario Regional Strategy, 1976.
8. Ontario Hydro, Energy Utilization and the Role of Electricity, 1976.
9. Ontario Hydro, Energy Application Survey, 1972, 1974, 1976.
10. Ontario Hydro, Ontario Hydro north of 50, November 1977.
11. Canadian Council on Rural Development, Environmentally Appropriate Technology for the Mid-North of Canada, 1976.
12. Ministry of Northern Affairs, Directory '78: Northern Ontario, 1978.
13. Ontario Research Foundation, An Analysis of the Potential for Wind Energy Produced in Northwestern Ontario, 1975.
14. R. J. Hall, Resource Availability and Utilization of Forests for Energy, Ontario Ministry of Natural Resources, 1976.
15. Advisory Group on Synthetic Liquid Fuels, Liquid Fuels in Ontario's Future: Findings and Recommendations, Ministry of Energy, 1979.
16. Dr. T. B. Reed, Proceedings, React '78: A Symposium on Economics of Renewable Energy and Energy Conservation Options, The Biomass Energy Institute, Winnipeg, 1978.
17. Ontario Research Foundation, Preliminary Assessment of the Potential for Large Wind Generators as Fuel Savers in AC Community Community Power Systems in Ontario, 1976.
18. Ontario Hydro, An Inventory of Potential Hydroelectric Powersites for the Supply of Power to Remote Native Communities in Northern Ontario, 1979.